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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 16 DECEMBER 1965 PART XI

The Bionomics and Ecology of *Anthocoris confusus* Reuter in Scotland

1. THE ADULT AND EGG PRODUCTION

By A. R. Hill,

(Zoology Department, The University, Glasgow)

Introduction

Anthocoris confusus Reuter is common and widely distributed in the British Isles. It has been recorded from all but nine counties in England and Wales and it appears to be widespread in Scotland also. The Scottish distribution of this and other species of *Anthocoris* is under study at present. Abroad, its range extends over Europe and Siberia (Butler, 1923).

Habitat

A. confusus is somewhat less ubiquitous than *A. nemorum* (Hill, 1957). It is more of a tree-dwelling species, although it can also be regularly collected on low-growing herbaceous vegetation. Butler reported that it is to be found especially on *Quercus* spp. and while it has been noted as being particularly common on these it has also been found during the present investigation on *Fagus sylvatica* L., *Betula pendula* Roth., *Sorbus aucuparia* L., *Alnus glutinosa* (L.) *Crataegus monogyna* Jacq., *Ulmus glabra* Huds., *Salix* spp., *Acer pseudoplatanus* L. and *Pinus sylvestris* L. It was also present on *Ulex europaeus* L., and occasionally on *Sarothamnus scoparius* (L.), *Myrica gale* L., and on herbaceous plants of the hedgerows and ground cover of woods, as well as on cultivated plants such as wheat, oats, potatoes, raspberries, etc. Anderson (1962) has described beech, oak, lime and sycamore as major host trees. As *A. confusus* is a predatory insect such a distribution indicates a wide range of prey species on which it can feed. Nevertheless, it would appear that it is more intimately associated with oak than with the other species and for this reason the greater part of the observations described here were carried out in oak woods while comparative studies were made on some other plant species.

Materials and Methods

Observations on the life history of the species were made in the field, in a gauze-walled insectory and in the laboratory. Regular and frequent visits were made to a small deciduous wood

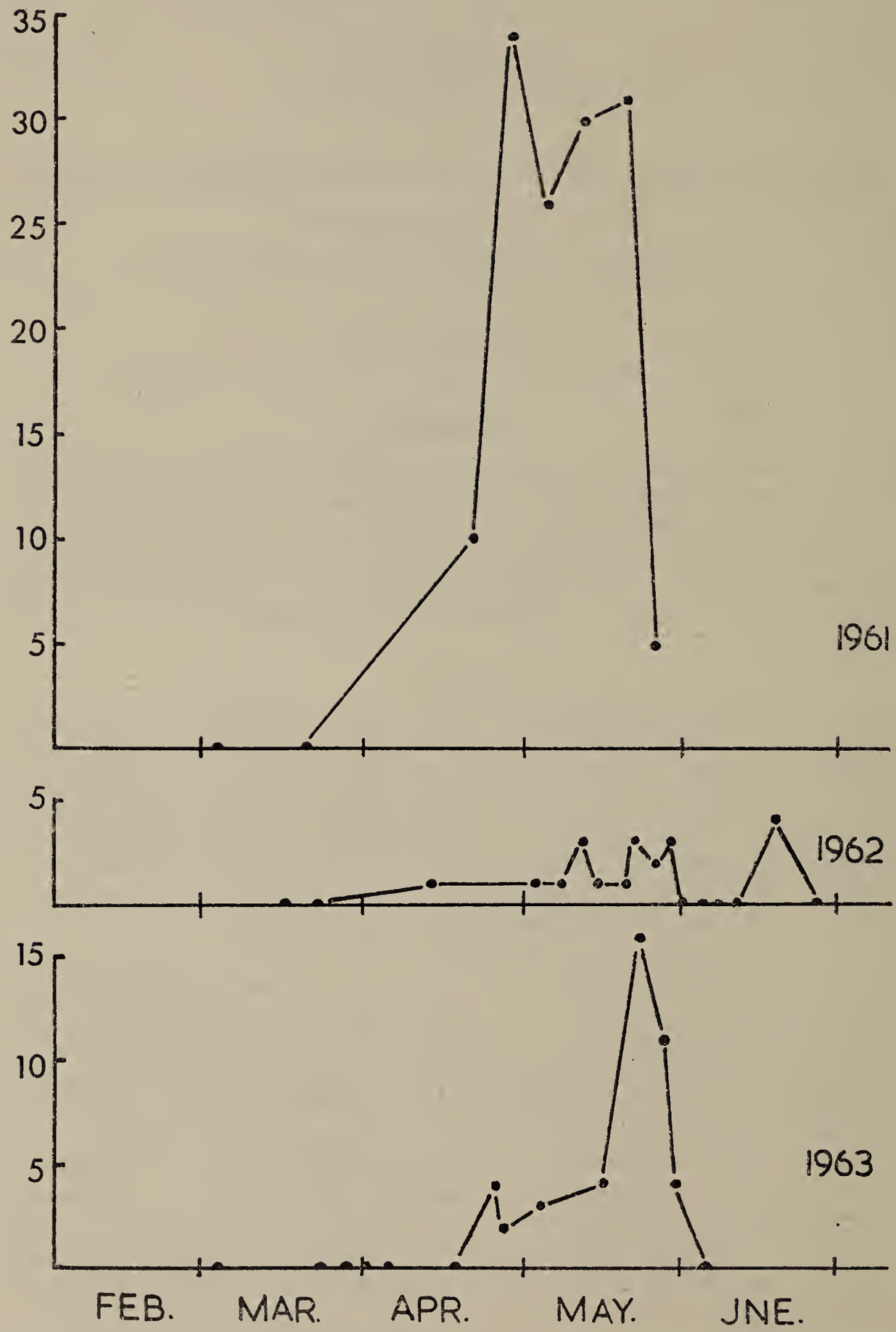

Figure 1.—Graphs of spring emergence. Abcissae time, ordinates, numbers of adult females in thirty samples.

near Drymen, Stirlingshire (grid ref. 485880) in which *Quercus robor* L. was the most abundant species. At each visit, 30 samples were taken by means of a beating tray (36″ × 30″). An attempt was made to standardise these samples by selecting sprays of leaves and twigs which completely covered the surface of the tray. The low growing nature of the trees made this comparatively easy. When the specimens had been identified and sexed they were returned to the trees. Other species of trees in the wood were similarly sampled for purposes of comparison and records were also kept of the numbers of other species of *Anthocoris* which were present. Sampling by such means has many imperfections but when performed consistently by one person the results give a reasonable reflection of population fluctuations.

Detailed observations on oviposition were made in the insectary where the rate, duration and rhythms of egg-laying could be accurately recorded. For this purpose, females, newly emerged from hibernation, were brought from the field early in the season and placed individually in 3″ × 1″ glass vials, fitted with corks and provided with a disc of damp filter paper to serve as a source of moisture (Hill, 1957). It was apparent from preliminary attempts to induce oviposition that *A. confusus* would not lay as satisfactorily on or in the filter paper as did *A. nemorum* (Hill, 1957). However, when plant material, such as short lengths of young hawthorn stem, was placed in each tube, the insects readily accepted them for egg-laying.

Hibernation and Spring Emergence

A. confusus was found throughout the year except between November and February; it overwinters in the adult stage. A wide search was made for hibernacula but the insects were nowhere found in aggregations. Anderson (loc. cit.) stated that the major overwintering site is beneath the bark scales of *A. pseudoplatanus*. However, this tree was not present in the wood at Drymen and hibernating specimens were obtained there most plentifully in litter on the ground. They were, however, found elsewhere under the bark of *A. pseudoplatanus, P. sylvestris* and *U. europaeus*.

Adults of *A. confusus* are slightly later in emerging from hibernation than those of its congeners, *A. nemorum, A. nemoralis* and *A. sarothamni*. The earliest recorded emergence over twenty years of casual observations was 7th April. During the four years of intensive study (1961-64) it was first recorded on 20th April, 13th April, 26th April and 7th April. The date of emergence is undoubtedly governed by climatic conditions especially temperature.

From figure 1 it can be seen that first emergence is usually slow but numbers of actively feeding individuals build up over a period which varies between one and five weeks depending on

climatic factors. For example, the winter of 1960-61 was not very severe but cold, wet weather continued until 10th April. Thereafter there was a distinct rise in the mean daily temperature and the first adults emerged from hibernation between 14th and 20th April and numbers increased rapidly until a peak was reached on 25th April. The weather of the latter half of the winter of 1961-62 was severe and again there was a late spring. Although the first emergence was observed on 13th April, the peak population, which was a small one, suggestive of extra high winter mortality, was not recorded until 18th June. In 1963 the second half of the winter was severe with a prolonged cold spell throughout January and February and the first half of March. The initial emergence was recorded on 26th April and the peak population occurred on 22nd May.

Sex Ratio

Both males and females can be collected annually in spring but the latter generally outnumber the former (Table 1). As with *A. nemorum* and *A. sarothamni* (Hill, 1957 and 1961) the females are almost all fertilized during the previous summer and autumn. The presence of a distinct male population in the spring places *A. confusus* in marked contrast to *A. nemorum* (Hill, loc. cit.). Some *A. confusus* males were observed to survive until as late as the first week of July. In the spring of 1962, males were markedly scarcer than usual. The reason for this may be that although the early winter was not severe, the prolonged cold spell after the New Year may have had a differentially more adverse effect on the over-wintering males than on the females.

TABLE 1

Sex Ratio of Spring Adults

	♂	♀
1961	1	3·3
1962	1	7·5
1963	1	3·5

Distribution on Plants in the Spring

Annually, on emergence from hibernation, *A. confusus* appeared first on *Salix* spp. in company with *A. nemorum* and *A. nemoralis*. Of the three it was not only the last to appear but was also the least numerous. After about a week, however, its numbers on willow decreased so much that it was difficult to find. *A. confusus* can regularly be found on *Quercus* sp. almost as soon as on *Salix* spp. and there it is not only more numerous but is, at first, the only species of *Anthocoris* present. Shortly thereafter, however, *A. nemorum* joins it but in small numbers which do not increase much until the oak buds have burst. Within 10 to 14 days of its emergence, *A. confusus* is to be found on various trees and shrubs. In the area under study these included

F. sylvatica, *C. monogyna*, *S. aucuparia*, *B. pendula*, *U. europaeus* and *S. scoparius*. It can also be collected from herbaceous plants forming the ground stratum of the wood. As the season advances *A. confusus* is ultimately found on the wide range of plants listed previously.

Activity of Females in the Spring

The active life of the female in spring can be divided into three parts (a) the pre-oviposition period, that is the time from the female's emergence from hibernation to when she lays her first ovum. (b) the oviposition period; (c) the post-oviposition period, that is the time between the female's laying of her last ovum and her death from natural causes.

(a) The duration of the pre-oviposition period varies to some extent between individuals. In 1961 the first ova were laid in the third week after the start of the spring emergence. In 1962 the first ova were not laid until week four. This may be accounted for by the slightly higher mean daily temperatures (10·8°C.) recorded in 1961, as compared with those for 1962 (10·1°C.). These observations were made on females emerging from hibernation in early spring. As emergence from hibernation takes place over an extended period, it is certain that pre-oviposition periods shown by females emerging later in the season, and therefore under warmer conditions, will be somewhat shorter.

It is at some point during the pre-oviposition period that the ovaries start to develop. The time at which this occurs was again found to vary considerably (see also Anderson, 1962). On emergence from hibernation, all the females had undeveloped ovaries. Their sperm reservoirs were, however, replete. Within seven days of the first appearance of specimens in spring it was possible to find a small number of females in which egg rudiments were present. In the majority of females, however, no such rudiments were evident and this continued to be the case for a considerable period of time. As late as seven weeks after the first spring emergence, the ova in many females had just started to grow. Others had ova grading up to the maximum size. It is not until well into June that every female examined was found to have fully mature ovaries. While these individual differences reflect variations in the times of emergence from hibernation already referred to, this aspect of the insect's biology requires more detailed investigation.

(b) The duration of the oviposition period can be most usefully considered in relation to the fecundity of individual females (see below). Considerable variations were again manifest although over the three years 1961-63 the average length of this period showed some consistency. In 1961 the range was from 11 days to 111 days with an average of 42·05 days. In 1962 it was 5 days to 108 days with an average of 41·75 days. In 1963, when the number of individuals observed was somewhat smaller, the range was 13 to 71 days with an average of 37·2 days (see Table 2).

TABLE 2

Anthocoris confusus, spring oviposition records for 1961 and 1962.
(Week number one is the week in which the females first emerged from hibernation.)

♀ No.	1961, WEEK NUMBER																						Total no. of ova per ♀	Length of oviposition period in days	Average no. of ova/days
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22			
1						1	14	14	8	12	6	6											61	41	1·48
2							12	11	5														28	18	1·55
3							6	2															8	11	0·72
4						2	12	4	11														29	26	1·11
5			3	0	0	2	19	10	17														51	49	1·04
6						2	12	19	3														36	18	2·0
7				1	0	1	8	11	16	13	16	9	5	2									82	68	1·2
8				1	0	0	6	12	6	12													37	45	0·82
9						2	4	19	8	5	9	1											48	39	1·23
10				3	0	0	14	14	19	11	12	7											80	56	1·42
11				1	0	3	8	14	11	10	13	5	10	14	6	5	3	0	1				104	111	0·93
12				1	11	6	10	13	23	10	24	14	14	15	7	2							150	84	1·66
13				5	7	2	1	2	4	0													21	43	0·48
14				3	2	1																	6	12	0·5
15				2	2	0																	4	11	0·36
16				1	7	2	5	3	6														24	39	0·61
17				5	7	6	12	8	9	6	11	1											65	54	1·20
18				1	7	2	2	5	1														18	37	0·48
19					2	2	0	0	0	0													4	36	0·11
20					5	7	14	9	5	5	5												50	43	1·16
Total No. of ova/week			3	24	50	41	159	170	152	84	96	43	29	31	13	7	3	0	1						
Av. No. of ova/♀/week			3	2	3·5	2·3	8·8	9·4	8·9	7·6	12·0	6·1	9·6	10·3	6·5	3·5	3	0	1						

TABLE 2 (*continued*)

♀ No.	1962, WEEK NUMBER																						Total no. of ova per ♀	Length of oviposition period in days	Average no. of ova/days
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22			
21				6	6																		12	5	2·4
22					1	8	13	20	29	16	13	20	16	16	7	2	0	0					161	89	1·80
23						5	5	17	20	12													59	41	1·43
24							3	14	19	13	12	18	18	16	11								124	60	2·0
25						7	6	15	23	9													60	30	2·0
26						7	10	6															23	15	1·53
27						3	2	1															6	17	0·35
28						3	4	7	13	11	5	6	10	8	5								72	67	1·07
29						3	3	3	12	12	11	13	11	10	10	4							92	68	1·35
30					5	7	5	7															24	24	1·0
31						9	8	20	27	1													65	28	2·32
32						7	4	5	8	9	10	12	1										56	58	0·96
33						3	13	8															24	20	1·20
34					3	6	7	6															22	24	0·91
35							7	21	26	14	13	16	22	18	11	20	7	0	6	0	0	0	181	108	1·67
36							1	9	14	5													29	14	2·07
Total No. of ova/week				6	15	68	91	159	191	102	64	85	78	68	44	26	7	0	6	0	0	0			
Av. No. of ova/♀/week				6	3·7	5·6	6·0	10·6	19·1	10·2	10·6	14·1	13·0	13·6	8·8	8·6	3·5	0	6	0	0	0			

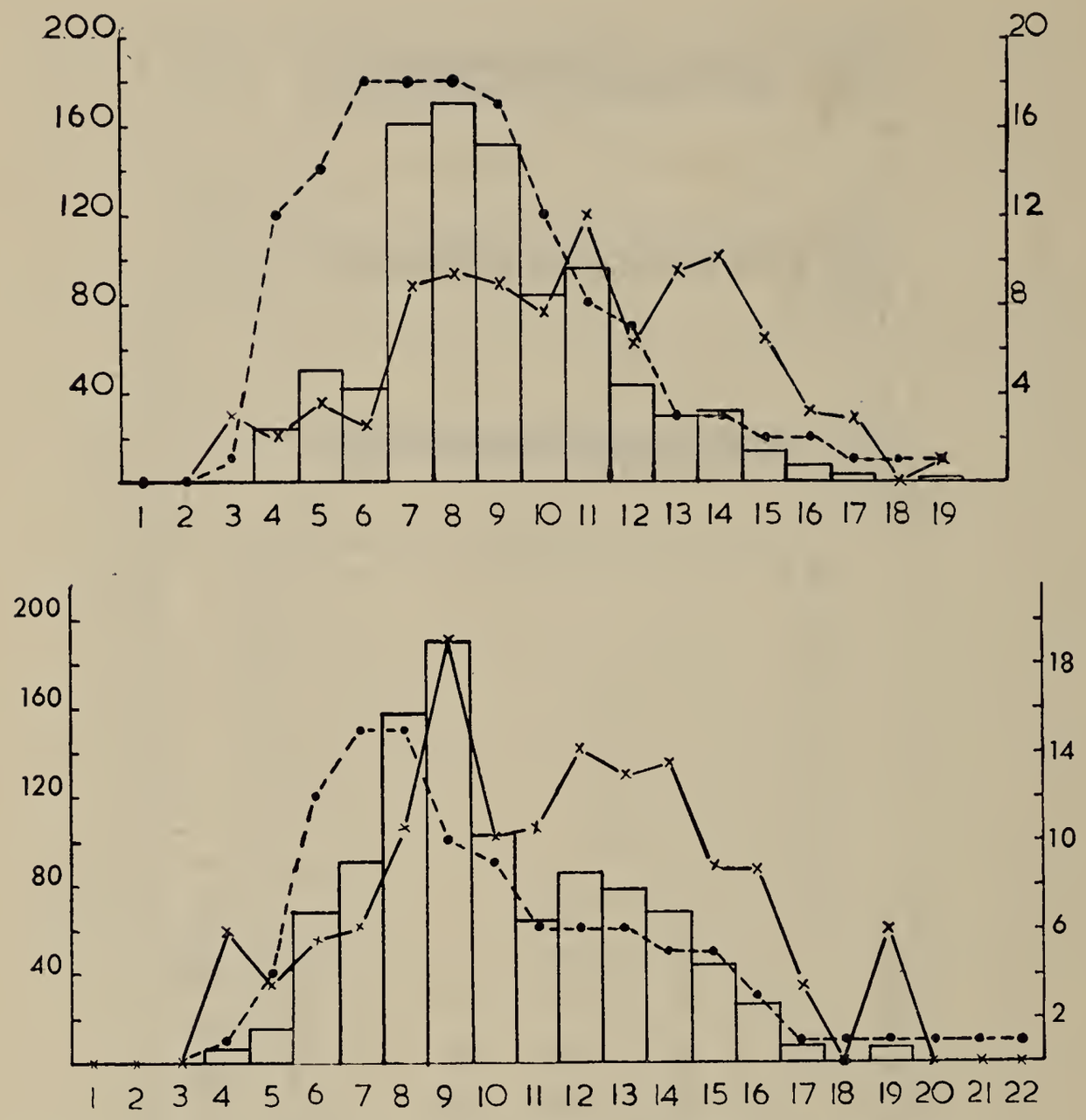

Figure 2.—Graphs of oviposition records: (a) 1961; (b) 1962. Abcissae time in weeks from date of first record of spring emergence. Left ordinate, numbers of ova laid (histograms); right ordinate, average number of ova laid per week x—x—x, and numbers of egg-laying females per week. - - -. - - -.

Of particular interest are the few females which live and oviposit for exceptionally long periods. In 1961 two females continued laying in the insectary from 17th May until 4th August and from 11th May until 26th August. They finally died on 8th August and 28th August respectively. In 1962 two females continued to lay from 17th May until 31st July and from 29th May until 18th August. These died on 13th August and 13th September respectively. Similar observations of long-lived, actively laying females were made on both the laboratory-reared stock and in the field where females, which undoubtedly belonged to the spring generation, were found at the end of August. Dissection of such wild females revealed them to be in an almost spent condition.

Individuals which oviposited for very short or very long periods were, however, in a minority; most females approximated quite closely to the mean.

The female population in spring would seem therefore to consist of three groups (1) those which live for a short period and lay a few ova; (2) those which live for an exceptionally long period and lay an abnormally large number of ova; (3) those which are intermediate in the duration of the oviposition period and usually (but not always) in the numbers of ova laid. A few members of this third group have been found to lay excessively large numbers of ova, for example, one female laid 144 ova in 47 days (see below). Whether these differences are genetically determined is not yet known.

(c) The majority of females showed no post-oviposition period in that they continued to ovipost to within a few hours of dying.

Some females, however, did cease to lay while remaining otherwise active. These comprised 19% of all the females studied. The duration of the post-oviposition period varied between 3 days and 27 days with an average of 12·8 days.

Why some females show this period still requires investigation. It is most unlikely to be related to the need for multiple copulation because the majority of females were capable of laying fertile ova for longer periods without recourse to multiple copulation. Indeed it would appear that the latter does not normally occur.

Oviposition

When the female has selected a suitable site for egg-laying, she comes to rest with her body slightly arched in the middle. The ovipositor is next inserted into the substratum. This is accomplished by gentle, undulating movements of the abdomen. During this process, the ovipositor projects from the ventral surface of the abdomen at an angle of about 90°. Once the ovipositor is inserted, pulsating movements are clearly visible in the abdomen, especially towards the posterior end. During the entire operation the antennae are held forward and diverge from one another in an upward direction, about 30° to 40° from horizontal and are quite motionless. The whole operation is completed in three to four minutes.

The ova were laid in petioles as well as in stems of the current year's growth. On the latter they were not orientated in any one direction the opercula pointed either upwards or downwards but the long axis of the egg invariably was parallel to that of the twig or petiole (see also Sands, 1957).

The Effect of the Substratum and Feeding on Oviposition

Experiments were performed to compare the egg-laying behaviour of *A. confusus* under the following conditions, (a) Plant material and prey provided. (b) No plant material nor prey provided. (c) Plant material provided but no prey. (d) Prey

provided but no plant material. Each group consisted of ten females. All the culture tubes were kept moist and were examined daily, when ova were counted and notes made on their condition and location.

In group (a) all but one female laid ova, the great majority of which were inserted into the plant tissue. Seven females survived for at least four weeks and two of these laid for nine weeks. In group (b) seven females died before one week had elapsed while one of the remainder survived for two weeks and the other two for three weeks, subsisting only on moisture from the wet filter paper. These three laid only one egg each on the surface of the filter paper and in each case the eggs were sucked dry by the female. In group (c) nine of the females died during the first week. The remaining individual survived into the third week and laid a single ovum which was also sucked dry. In group (d) five of the females survived for periods between nine and fifteen weeks. All laid ova. At first there was a strong tendency on the part of some individuals to ovipost on the surface of the moist filter paper and invariably such ova were sucked dry within a short time of being laid. However, after two weeks this tendency decreased but never disappeared completely.

It can be concluded that in the absence of animal food spring females of *A. confusus* do not survive for long and, although the ovaries seem capable of developing to a stage where fully formed ova are present, the females do not succeed in laying more than one or two eggs. Individuals which were provided with only plant tissue fared no better so far as oviposition is concerned than those supplied with only moisture. It does not appear, therefore, that *A. confusus* makes use of plant sap for nutritional purposes. In the presence of abundant animal food *A. confusus* lays readily. The insertion of the ova into the substratum is initially more regularly performed where the latter is of plant tissue. In the absence of the latter a proportion of ova are laid on the surface of the substratum and on later being discovered by the female are pierced and sucked dry. This abnormal behaviour seems to decrease after a short time, however.

Numbers of ova laid

In Table 2 the total numbers of ova laid by each female per week under insectary conditions are given. Week 1 is the week in which *A. confusus* was first found to have emerged from hibernation. The duration of the oviposition period and the number of ova laid by the several females observed varied considerably. In both 1961 and 1962 the peak period of oviposition was reached during the sixth week after commencement as shown by the figures of average numbers of ova laid per female per week. A few females which appeared healthy and which started to oviposit, in most cases, as quickly as the others, were, for unknown reasons, short-lived and laid fewer ova per day and therefore markedly smaller totals of ova than the average females. On the

other hand the largest number of ova laid in one week by one female was 29 in 1962 but two other females were almost as prolific, laying 27 and 26. Such exceptional individuals merit closer study. The average number of ova laid per female over the whole season was 44·8 (range 4 to 140) in 1961 and 64·2 (range 6 to 181) in 1962. If the females which laid exceptionally large or exceptionally small numbers of ova be excluded, then the averages are 48·8 (range 18 to 104) for 1961, 58·6 (range 22 to 92) for 1962. The latter figures probably give a more realistic picture of oviposition by *A. confusus* but the existence of the exceptional individuals must also be borne in mind as they may form as much as one-third of the population.

Relationship between weight of female and the number of ova laid

In view of the considerable variation in fecundity between females an attempt was made to correlate this with the body weights of the individuals. Body weight at emergence from hibernation was found to vary from 1·0 mg. to 1·4 mg. Examination of the data, however, yields only a slight and not significant correlation between weight and fecundity. The most fecund individual was also the heaviest one and the females which were least fecund were always in the lowest part of the weight range. In the intermediate part of the range, however, individuals of equal initial weights laid markedly different numbers of ova.

Description of the ovum

The ovum shows the characteristic form of *Anthocoris* ova: elongate, slightly curved with a distinct sculptured operculum at one end. It is entirely white when laid and a faint hexagonal pattern of ovarian follicular cells can be seen on the chorion. The diameter of the ovum increases to a maximum near the rounded end. The operculum is circular with a clearly marked pattern which differs somewhat from that of *A. nemorum* in that the radial follicular pits are narrower and more numerous while the central zone is less extensive and is composed of smaller pits. The average dimensions of the ovum are, length 0·63 mm., width at the broadest region, 0·22 mm. Sands (1957) recorded the length as 0·75.

Longevity of Females

Records were kept of the duration of spring and summer life-span of some 18 individual females. These figures, however, represent only a part of the total life-span of the insects. It must be remembered that each female had hatched and developed during the previous spring or summer and had spent the winter in hibernation. No data are available for these preiods and it is not yet clear to what extent, if any, the date of hatching and the date of the imaginal moult influence the duration of the adult life in the following spring and summer. The duration of the

period under observation ranges from 32 days to 125 days. The last figure, however, was far in excess of any of the others. The next highest value being 96 days, while the average life-span was 64·27 days.

Summary

(1) The distribution and habitat of *A. confusus* are discussed with special reference to Scotland.
(2) Observations on the emergence from hibernation of adults in spring are described, and the distribution of the species on various host plants is discussed. Reference is made to the sex ratio and a comparison is drawn with observations made previously on *A. nemorum* and *A. sarothamni*.
(3) An account is given of the spring activity of the females, with special reference to oviposition and the factors which determine the egg-laying activities of this species. The ovum is described.
(4) The length of life of the females in spring is discussed.

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